

Profit Maximization by a Perfectly Competitive Firm

A perfectly competitive firm will maximize its total profit by producing the output level at which marginal revenue equals marginal cost. You need to understand how economists find these two important “marginal” measures.

Part A: Revenue Measures of a Perfectly Competitive Firm

A perfectly competitive firm is a “price taker.” This means it has no control over price and will charge the market-determined price for its product. In fact, because it is such a small participant in the market, a perfectly competitive firm can sell all the output it wants at the market price. It does not have to reduce its price to sell additional units. This makes the revenue measures of a perfectly competitive firm easy to calculate and to graph.

1. Assume the market for yo-yos is perfectly competitive and that the market price currently is \$17 per box of yo-yos. Complete Table 3-6.1, which has the three revenue measures of a typical firm in this market. Put the MR values at the new output level. For example, when the firm increases output from four to five units, its total revenue increases by \$17, so put “+\$17” in the MR column for $Q = 5$.



Table 3-6.1

Revenue Measures of a Perfectly Competitive Firm

| (1) Output (Q) [boxes of yo-yos] | (2) Price (P) [per box] | (3) Total revenue $TR = P \times Q$ | (4) Marginal revenue $MR = \Delta TR / \Delta Q$ | (5) Average revenue $AR = TR / Q$ |
|--|-------------------------------|---|--|---|
| 0 | \$17 | \$0 | — | — |
| 1 | \$17 | +\$17 | +\$17 | \$17 |
| 2 | \$17 | +\$34 | +\$17 | \$17 |
| 3 | \$17 | \$51 | +\$17 | \$17 |
| 4 | \$17 | +\$68 | +\$17 | \$17 |
| 5 | \$17 | +\$85 | +\$17 | \$17 |
| 6 | \$17 | +\$102 | +\$17 | \$17 |
| 7 | \$17 | +\$119 | +\$17 | \$17 |
| 8 | \$17 | \$136 | +\$17 | \$17 |
| 9 | \$17 | +\$153 | +\$17 | \$17 |
| 10 | \$17 | +\$170 | +\$17 | \$17 |

2. What happens to the value of MR as more output is sold? Why?

MR is a constant value because the firm does not have to lower price to sell an extra unit. Thus, the change in total revenue for an extra unit is equal to the market price.

3. What is the relationship between MR and AR at every output level? Why?

The two measures are equal because the firm does not have to lower price to sell an extra unit of output.

4. What happens to the value of TR each time the firm sells one more unit of its good? Why?

TR increases by an amount equal to the market price. Since it does not have to reduce price, TR increases by the same amount with each new unit of output. This increase in TR is the firm's MR.

5. Why is P equal to \$17 at every level of Q?

Because the firm is a price taker, it can sell all it wants at the market price of \$17.

6. What is the relationship between P, MR, and AR? Why?

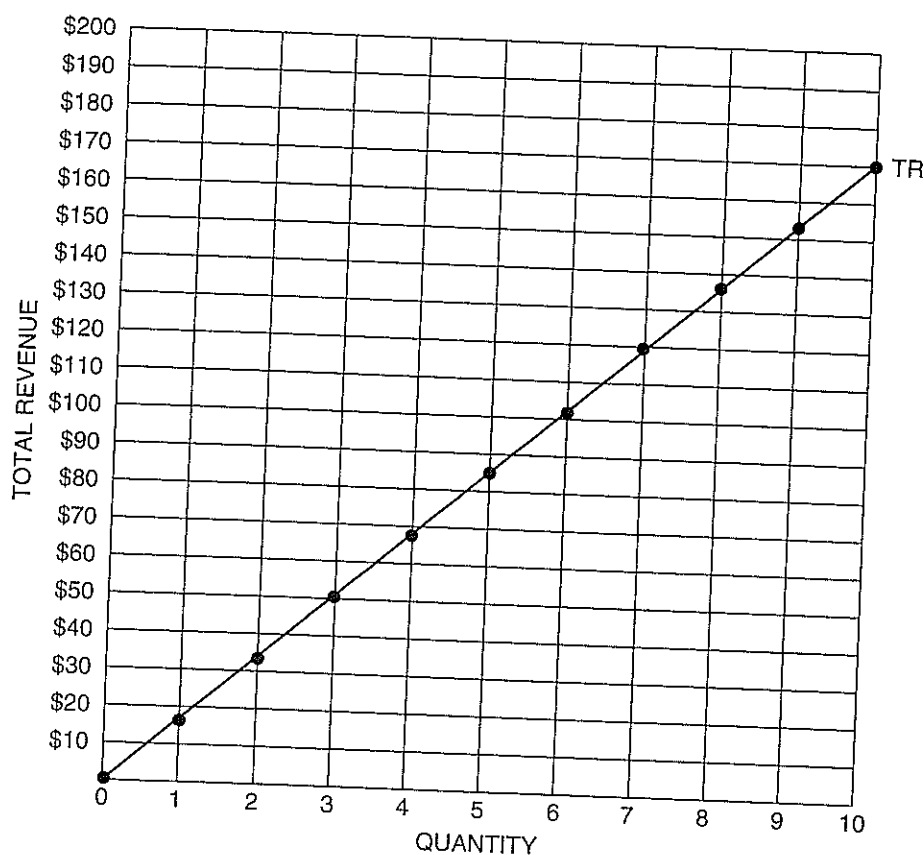
For a perfectly competitive firm, these three measures are equal to each other because the firm does not have to lower price to sell more output.

7. Plot the firm's total revenue data in Figure 3-6.1.



Figure 3-6.1

Total Revenue Function of a Perfectly Competitive Firm



8. The slope of the total revenue function is $\Delta TR / \Delta Q$. What economic function does this ratio represent? Why is the TR curve a straight line?

The slope of the TR function is MR. For a perfectly competitive firm, the TR function is a straight line because MR is a constant value.

9. If the market price increases, what will happen to the slope of the firm's TR curve? Will the TR curve still begin at the origin?

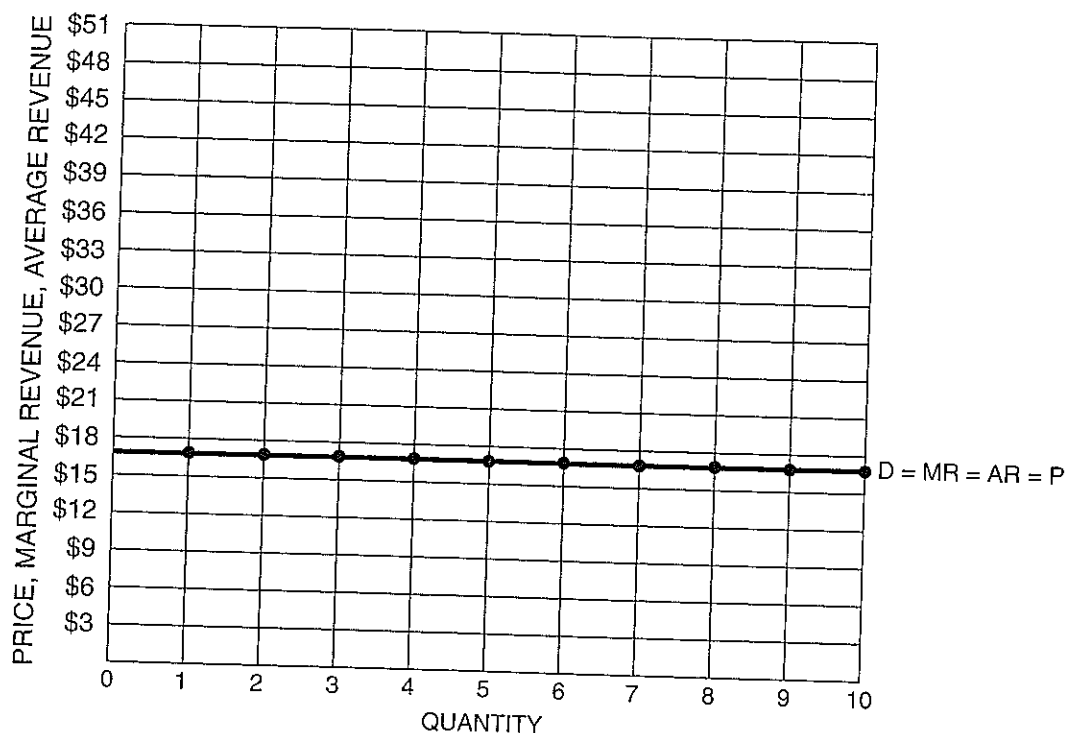
The TR function will be steeper because MR will be larger. The TR curve will still begin at the origin.

10. Plot the firm's marginal revenue, average revenue, and demand data in Figure 3-6.2.



Figure 3-6.2

Marginal Revenue, Average Revenue, and Demand Functions of a Perfectly Competitive Firm



11. Does the demand curve D represent the firm's demand for something, such as inputs?
No, it is the demand of consumers for the product of the firm.
12. Why is the demand function horizontal?
It is horizontal because the firm does not have to reduce its price to sell more output. It can sell all it wants at the market price of \$17.
13. What would happen to the quantity demanded of the firm's product if it increased the price above the market price of \$17? What does this tell you about the price elasticity of demand for the firm's product?
The quantity demanded would drop to zero because consumers would buy yo-yos from other firms at the market price. This means the demand facing a perfectly competitive firm is perfectly elastic—a slight price increase moves the firm from being able to sell all it wants to selling no units at all.

14. Would you recommend that this firm lower its price below the market price of \$17? Why?
No. It can sell all it wants at the market price, so why reduce the price?
15. What do you note about the relationship between price and marginal revenue for a perfectly competitive firm? What about between price and average revenue?
 $P = MR$ and $P = AR$ for a perfectly competitive firm.

Part B: Cost Measures of a Perfectly Competitive Firm

The short-run cost curves of a perfectly competitive firm give you values of the various cost measures at different output levels.

16. Complete Table 3-6.2, which has the seven cost measures of a typical firm in this market. Put the MC values at the new output level. For example, when the firm increases output from four to five units, its total cost increases by \$4, so put “+\$4” in the MC column for $Q = 5$. Some of the cost values are provided for you.



Table 3-6.2

Cost Measures of a Perfectly Competitive Firm

| (1) Output (Q) [boxes] | (2) Total fixed cost (TFC) | (3) Total variable cost (TVC) | (4) Total cost (TC) | (5) Marginal cost (MC) $= \Delta TC / \Delta Q$ | (6) Average fixed cost (AFC) $= TFC / Q$ | (7) Average variable cost (AVC) $= TVC / Q$ | (8) Average total cost (ATC) $= TC / Q$ |
|------------------------------|--|---|------------------------------|--|--|---|---|
| 0 | \$40.00 | \$0.00 | \$40.00 | — | — | — | — |
| 1 | \$40.00 | \$10.00 | \$50.00 | +\$10.00 | \$40.00 | \$10.00 | \$50.00 |
| 2 | \$40.00 | \$16.00 | \$56.00 | +\$6.00 | \$20.00 | \$8.00 | \$28.00 |
| 3 | \$40.00 | \$21.00 | \$61.00 | +\$5.00 | \$13.33 | \$7.00 | \$20.33 |
| 4 | \$40.00 | \$26.00 | \$66.00 | +\$5.00 | \$10.00 | \$6.50 | \$16.50 |
| 5 | \$40.00 | \$30.00 | \$70.00 | +\$4.00 | \$8.00 | \$6.00 | \$14.00 |
| 6 | \$40.00 | \$36.00 | \$76.00 | +\$6.00 | \$6.67 | \$6.00 | \$12.67 |
| 7 | \$40.00 | \$45.50 | \$85.50 | +\$9.50 | \$5.71 | \$6.50 | \$12.21 |
| 8 | \$40.00 | \$56.00 | \$96.00 | +\$10.50 | \$5.00 | \$7.00 | \$12.00 |
| 9 | \$40.00 | \$72.00 | \$112.00 | +\$16.00 | \$4.44 | \$8.00 | \$12.44 |
| 10 | \$40.00 | \$90.00 | \$130.00 | +\$18.00 | \$4.00 | \$9.00 | \$13.00 |

17. What happens to the value of AFC as Q rises? Why?
AFC always decreases as Q rises because $AFC = TFC/Q$. Since TFC is constant, an increase in Q must reduce AFC.

18. What happens to the value of AVC as Q increases? Why?
AVC decreases, then increases as the firm increases its level of output. Initially, MC is less than AVC which makes AVC decrease. When MC eventually rises above AVC, AVC will increase.

19. What happens to the value of MC as Q increases? Is this trend related to the marginal physical productivity of the firm's variable resources? Explain.
MC decreases, then increases as the firm increases output. Yes, the shape of the MC curve is inversely related to the shape of the MPP curve. When MPP increases, MC decreases. When MPP decreases, MC increases. When MPP is maximized, MC is minimized.

20. Is the value of MC the same whether it is computed as a change in TC or as a change in TVC? Why?
Yes, the only change in a firm's TC is the change in its TVC. So MC is the same using a change in either TC or TVC when an extra unit of output is produced.

21. Why does the value of TVC continue to get larger as the firm produces more Q?
In the short run, the only way the firm can produce more output is by adding more units of its variable resource (labor). Thus, its total outlay on labor must increase as the firm makes more output.

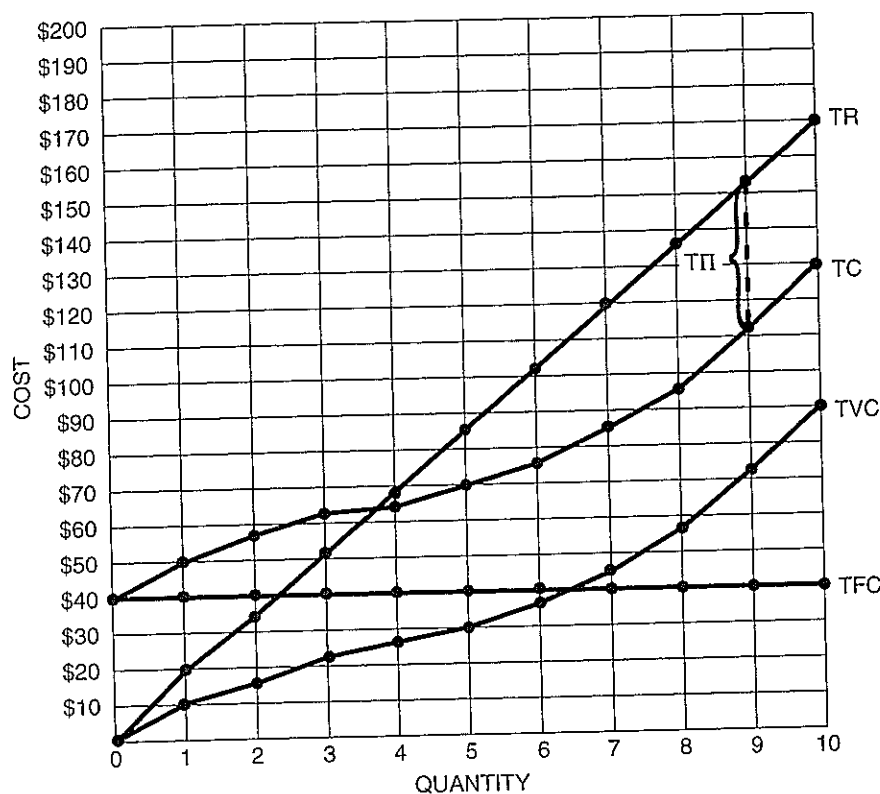
22. The slope of the TC curve is $\Delta TC / \Delta Q$. Do you recognize this ratio as the expression of some other important economic function?
Yes, the slope of the TC curve is MC.

23. Plot the firm's TC, TVC, and TFC data in Figure 3-6.3.



Figure 3-6.3

TC, TVC, and TFC Functions of a Perfectly Competitive Firm



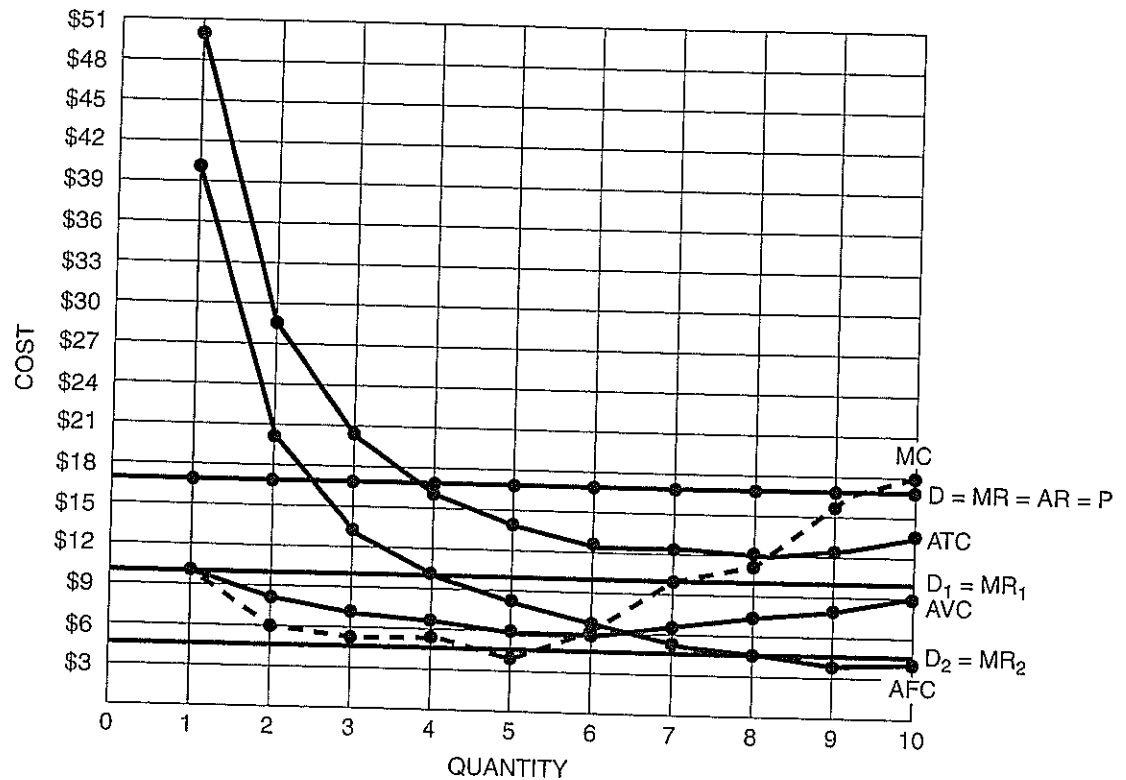
24. What does the vertical gap between the TC and TVC represent? What happens to the size of this gap as the firm increases its level of production?
The gap represents TFC which does not change with output. The TFC gap is the same at all output levels.
25. Why does the TC cost curve not begin at the origin?
Because even if it produces no output, the firm still has TFC. The TC curve begins at the level of TFC.
26. Why does the TVC curve have the same slope as the TC curve?
Both the TVC and TC curves have slope equal to MC. $MC = \Delta TC / \Delta Q = \Delta TVC / \Delta Q$.

27. Plot the firm's ATC, AVC, AFC, and MC data in Figure 3-6.4 and answer the questions that follow the graph. Connect the MC values with a dotted line in your graph.



Figure 3-6.4

ATC, AVC, AFC, and MC Functions of a Perfectly Competitive Firm



28. Why does the vertical gap between the ATC and AVC curves get smaller as the firm increases its Q ?
That gap is AFC which decreases as the level of output increases.
29. At what unique point does the MC curve intersect both the AVC curve and the ATC curve? Why?
The MC curve intersects the AVC and ATC curves at their minimum points. When MC is below these average curves, they decrease. When MC is above them, they increase.
30. Between $Q = 6$ and $Q = 8$, AVC is rising while ATC is falling. How can this be?
This is because over this output range, the decrease in AFC is greater than the increase in AVC. As a result, ATC continues to fall.

Part C: Profit Maximization by a Perfectly Competitive Firm

Now that you have mastered the revenue and cost terms for a perfectly competitive firm, you can bring them together to determine how many units of output the firm should produce to maximize its total profit.

31. Complete Table 3-6.3 using your data from Tables 3-6.1 and 3-6.2. Some data have been entered for you.



Table 3-6.3

A Perfectly Competitive Firm Maximizes Total Profit

| Q | TR | TC | TII | MR | MC | MII |
|----|----------|----------|----------|----------|----------|----------|
| 0 | \$0.00 | \$40.00 | -\$40.00 | — | — | — |
| 1 | \$17.00 | \$50.00 | -\$33.00 | +\$17.00 | +\$10.00 | +\$7.00 |
| 2 | \$34.00 | \$56.00 | -\$22.00 | +\$17.00 | +\$6.00 | +\$11.00 |
| 3 | \$51.00 | \$61.00 | -\$10.00 | +\$17.00 | +\$5.00 | +\$12.00 |
| 4 | \$68.00 | \$66.00 | \$2.00 | +\$17.00 | +\$5.00 | +\$12.00 |
| 5 | \$85.00 | \$70.00 | \$15.00 | +\$17.00 | +\$4.00 | +\$13.00 |
| 6 | \$102.00 | \$76.00 | \$26.00 | +\$17.00 | +\$6.00 | +\$11.00 |
| 7 | \$119.00 | \$85.50 | \$33.50 | +\$17.00 | +\$9.50 | +\$7.50 |
| 8 | \$136.00 | \$96.00 | \$40.00 | +\$17.00 | +\$10.50 | +\$6.50 |
| 9 | \$153.00 | \$112.00 | \$41.00 | +\$17.00 | +\$16.00 | +\$1.00 |
| 10 | \$170.00 | \$130.00 | \$40.00 | +\$17.00 | +\$18.00 | -\$1.00 |

32. The value of TII is greatest at $Q = 9$ units. The maximum TII = \$41.00.

33. The firm should produce each unit for which $MR > MC$. The last unit with $MR > MC$ is the ninth unit, which has $MII = +\$1.00$.

34. Should the firm produce the tenth unit of Q ? Why?
No, because that unit has $MR < MC$ which means it has a negative MII. If the firm sold that unit, TII would fall by \$1.00.

35. $M\Pi$ has its greatest value at $Q = \underline{5}$ units. Should this be the Q level the firm decides to produce? Why?

No, because the sixth through the ninth units each have positive $M\Pi$ ($MR > MC$) which means they will increase the firm's $T\Pi$.

36. Go back to Figure 3-6.3 and draw the firm's TR function. (You can get it from Figure 3-6.1). Label the function " TR ."

37. What do we call the vertical gap between the TR and TC curves?

That vertical gap is total profit ($T\Pi$).

38. We saw in Table 3-6.3 that this firm should produce $Q = \underline{9}$ units to maximize its $T\Pi$. Indicate the part of Figure 3-6.3 that represents this maximum $T\Pi$.

39. Go back to Figure 3-6.4 and draw the firm's D , MR , and AR functions at the current market price of \$17. (You can get these from Figure 3-6.2). Label the functions.

40. The last unit of output for which $MR > MC$ is the ninth unit. This is the last unit the firm should produce in order to maximize its $T\Pi$.

41. What does the vertical gap between the MR and MC curves represent?

That vertical gap is marginal profit ($M\Pi$). As long as the gap is positive, the firm should keep producing more units of output.

Part D: When Is a Firm's Best Just Not Good Enough?

You proved this firm can earn a positive total profit if the market price is \$17. But what if the market price drops? Since a perfectly competitive firm is a price taker, it will have to sell its product at the lower market price, which will reduce its total profit.

42. Assuming all its costs are unchanged, what will happen to the perfectly competitive firm if the market price drops to \$10? In Figure 3-6.4, draw a new " $D_1 = MR_1$ " line at the price of \$10.

(A) Based on a comparison of MR and MC, the firm's optimal Q level is 7 units.

(B) Its TR will be (*greater than / equal to / less than*) its TC at this Q level.

(C) Its TR will be (*greater than / equal to / less than*) its TVC.

(D) What should the firm do? Choose one of these decisions:

(1) It should produce its optimal Q even though it will make a loss.

(2) It should shut down and produce no Q this period.

43. Assuming all its costs are unchanged, what will happen to the perfectly competitive firm if the market price drops to \$5? In Figure 3-6.4, draw a new " $D_2 = MR_2$ " line at the price of \$5.

(A) Based on a comparison of MR and MC, the firm's optimal Q level is 5 units.

(B) Its TR will be (*greater than / equal to / less than*) its TC at this Q level.

(C) Its TR will be (*greater than / equal to / less than*) its TVC.

(D) What should the firm do? Choose one of these decisions:

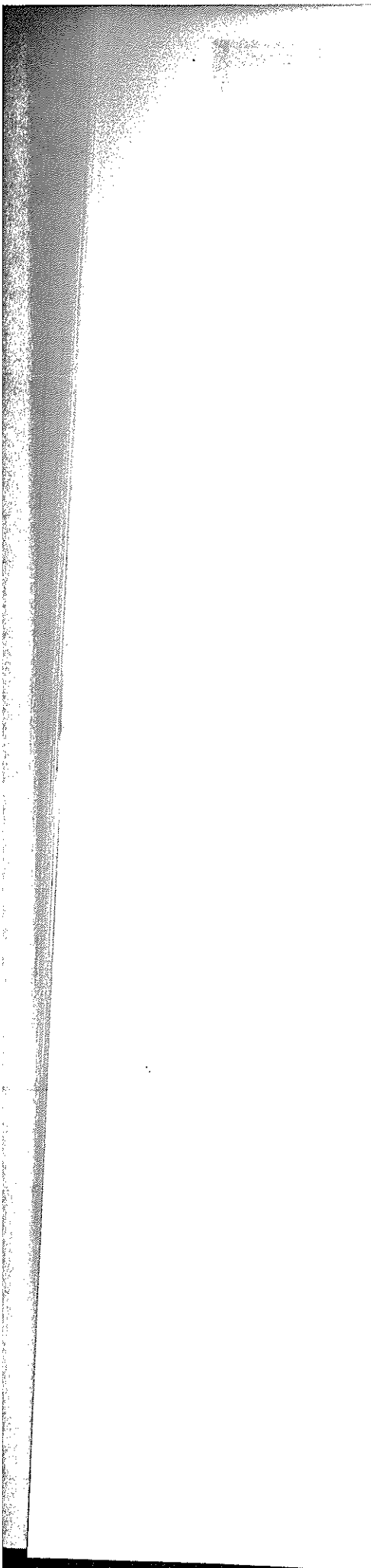
(1) It should produce its optimal Q even though it will make a loss.

(2) It should shut down and produce no Q this period.

Note: Even though economists chant, "Produce where $MR = MC$," in a discrete case with a limited number of Q levels being considered, there might not be a level of Q where $MR = MC$. In such a case, the firm should produce units for which $MR > MC$ and stop before it produces units for which $MR < MC$. That's what you did in this example.

44. A puzzle for you! Economists say a perfectly competitive firm can sell at the Q it wants at the going market price. So why doesn't a single firm decide to produce all the Q that is demanded in the market?

It will only produce more output as long as MR is greater than or equal to MC. Once the firm's MC rises about its MR, the firm will decide not to produce any more units.



Short-Run Equilibrium and Short-Run Supply in Perfect Competition

The word “equilibrium” refers to being in a state of rest or balance. You know the meaning of this term in the context of a competitive market: the equilibrium price is the one at which the quantity demanded is equal to the quantity supplied. Neither the buyers nor the sellers have reason to move from this spot, unless factors cause the demand or supply curve to shift.

Part A: Short-Run Equilibrium for a Perfectly Competitive Firm

A perfectly competitive firm is in a *short-run equilibrium* position when it produces the output level Q^* at which marginal revenue (MR) is equal to marginal cost (MC). The firm will stay at this output level unless something causes a change in its MR curve or MC curve. In its short-run equilibrium position, the firm could be in any of four profit scenarios as shown in Table 3-7.1.

1. In the last column, circle what you feel the firm should do in each of these cases—produce or shut down.



Table 3-7.1

Four Possible Total Profit Positions of a Firm in Short-Run Equilibrium

| Total profit (π) at Q^* where $MR = MC$ | Total revenue (TR) compared to total cost (TC) and total variable cost (TVC) at Q^* | What should the firm do? |
|---|---|---|
| 1. $\pi > \$0$ | $TR > TC$ | <u>Produce Q^*</u> / shut down |
| 2. $\pi = \$0$ | $TR = TC$ | <u>Produce Q^*</u> / shut down |
| 3. $\pi < \$0$ | $TVC < TR < TC$ | <u>Produce Q^*</u> / shut down |
| 4. $\pi < \$0$ | $TR < TVC < TC$ | Produce Q^* / <u>shut down</u> |

Note: You will see in Activity 3-8 how a perfectly competitive firm moves from a position of short-run equilibrium to one of long-run equilibrium where it must break even (total profit = \$0).

Part B: Short-Run Supply Curve of a Perfectly Competitive Firm

A market supply curve tells you how many units of a good or service producers will provide at different prices, other things being constant. The typical market supply curve is upward sloping because producers will put more units on the market at a higher price. A perfectly competitive firm also has a supply curve that is upward sloping. The basis of its short-run supply curve is its marginal cost curve as shown in the following exercise. Table 3-7.2 has information about some of the daily cost functions of the Fiasco Company, which sells its product in a perfectly competitive market.

- Fill in the missing cost values in Table 3-7.2.



Table 3-7.2

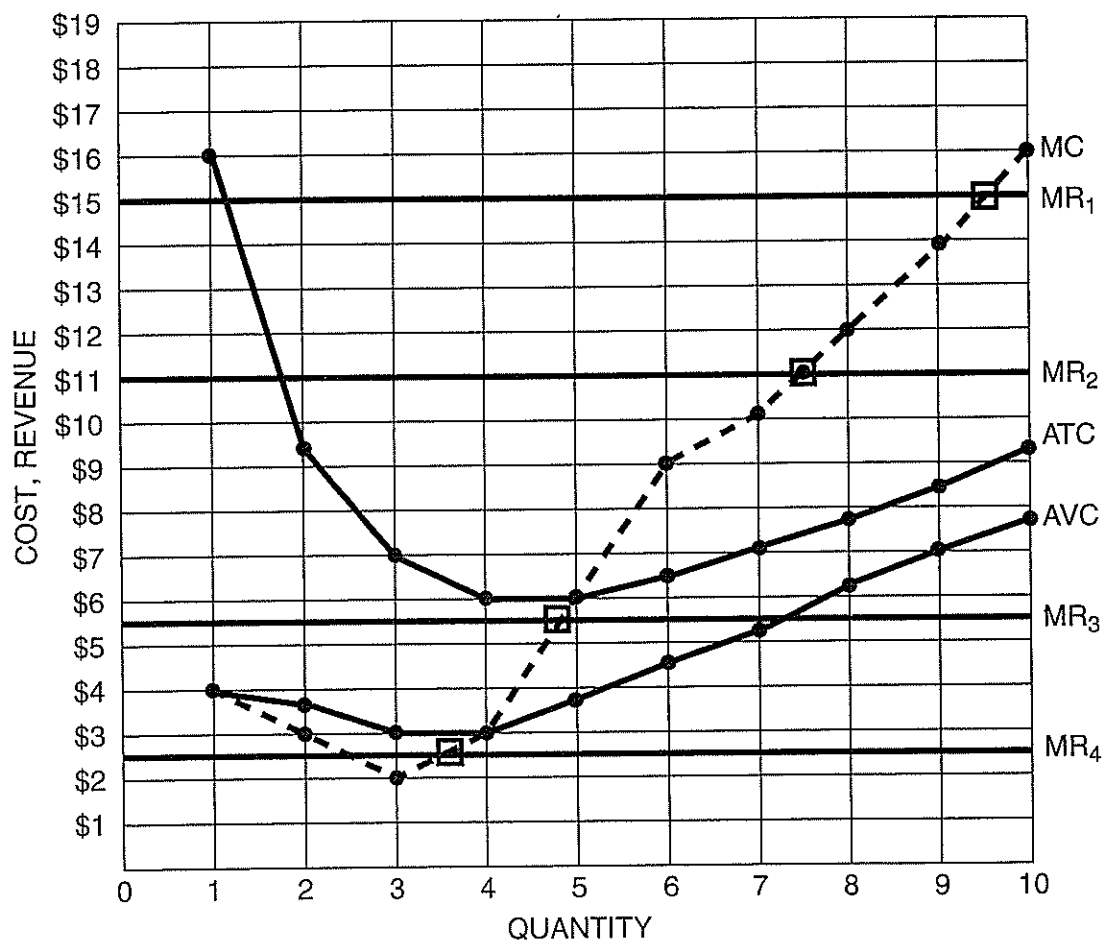
Cost Functions of a Perfectly Competitive Firm

| Q | TC | TVC | MC | Average total cost (ATC) | Average variable cost (AVC) |
|----|----------------|----------------|-----------------|--------------------------|-----------------------------|
| 0 | \$12.00 | \$0.00 | — | — | — |
| 1 | \$16.00 | \$4.00 | +\$4.00 | \$16.00 | \$4.00 |
| 2 | \$19.00 | \$7.00 | +\$3.00 | \$9.50 | \$3.50 |
| 3 | \$21.00 | \$9.00 | +\$2.00 | \$7.00 | \$3.00 |
| 4 | \$24.00 | \$12.00 | +\$3.00 | \$6.00 | \$3.00 |
| 5 | \$30.00 | \$18.00 | +\$6.00 | \$6.00 | \$3.60 |
| 6 | \$39.00 | \$27.00 | +\$9.00 | \$6.50 | \$4.50 |
| 7 | \$49.00 | \$37.00 | +\$10.00 | \$7.00 | \$5.29 |
| 8 | \$61.00 | \$49.00 | +\$12.00 | \$7.63 | \$6.13 |
| 9 | \$75.00 | \$63.00 | +\$14.00 | \$8.33 | \$7.00 |
| 10 | \$91.00 | \$79.00 | +\$16.00 | \$9.10 | \$7.90 |

3. In Figure 3-7.1, plot and label the ATC, AVC, and MC curves of the firm. Plot the MC values at the higher of the two output levels. For example, when the firm increases output from 5 units to 6 units, its TC increases by \$9, so plot the $MC = \$9$ value at $Q = 6$. Use a dotted line to draw the MC curve.



Figure 3-7.1
Cost Curves of the Fiasco Company



How many units of Q should the firm produce to maximize its total profit? Given its cost functions, the answer depends on the market price that the perfectly competitive firm must charge for its product. Consider these four possible market prices: \$15.00, \$11.00, \$5.50, and \$2.50.

4. In Figure 3-7.1, draw the appropriate marginal revenue curve for each of these prices (P) and label them as follows: MR_1 (for $P = \$15.00$), MR_2 (for $P = \$11.00$), MR_3 (for $P = \$5.50$), and MR_4 (for $P = \$2.50$).

5. Using Figure 3-7.1 and Table 3-7.2, complete Table 3-7.3 and determine how many units of Q the firm should produce at each of the four market prices.



Table 3-7.3

Optimal Output Level for the Fiasco Firm at Different Market Prices

| (1) P | (2) Q* (units) | (3) TR | (4) TVC | (5) TFC | (6) TII |
|----------|-------------------|-----------|------------|------------|------------|
| \$15.00 | 9 units | \$135.00 | \$63.00 | \$12.00 | \$60.00 |
| \$11.00 | 7 units | \$77.00 | \$37.00 | \$12.00 | \$28.00 |
| \$5.50 | 4 units | \$22.00 | \$12.00 | \$12.00 | -\$2.00 |
| \$2.50 | 3 units | \$7.50 | \$9.00 | \$12.00 | -\$13.50 |

6. What rule did you use to determine the Q level that would maximize the firm's TII if P were \$15.00? Why?
The rule to use is $MR = MC$. At the price of \$15.00, you can see how many units had MR greater than or equal to MC. This gives 9 units.
7. Did you use this same rule to find the profit-maximizing Q level at P of \$11.00? Why?
Yes. The first 7 units had MR greater than MC. Since the MR of the eighth unit was less than its MC, the eighth unit is not profitable at a price of \$11.00.
8. Should the firm shut down if P is \$5.50? What if P is \$2.50? Explain.
At both of these prices the firm will make a loss because $P < ATC$. However, $P > AVC$ at a price of \$5.50, so the firm should use the $MR = MC$ rule to produce 4 units at a smaller loss than it would have if it shut down. At a price of \$2.50, $P < AVC$, so the firm is better off shutting down and having a loss equal to its TFC.
9. Complete Table 3-7.4, which is the supply schedule for the Fiasco Firm. It shows how many units the firm will provide to the market at different prices.



Table 3-7.4

Supply Schedule for the Fiasco Firm

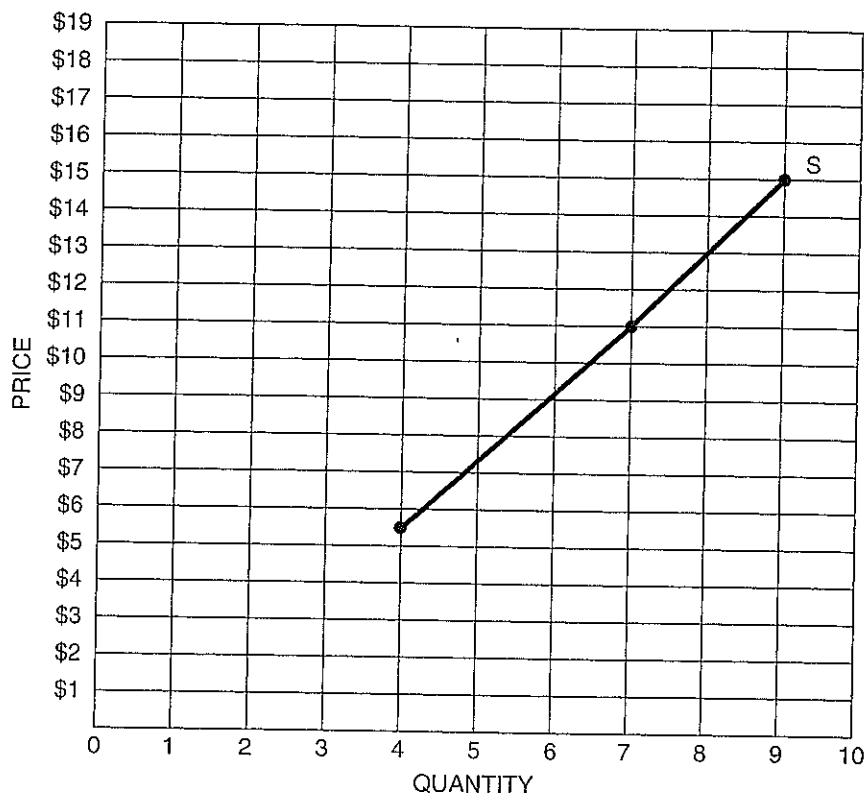
| P | Q supplied (units) |
|---------|--------------------|
| \$15.00 | 9 units |
| \$11.00 | 7 units |
| \$5.50 | 4 units |
| \$2.50 | 0 units |

10. Plot the supply curve of the Fiasco Firm in Figure 3-7.2. Label the curve as "S."



Figure 3-7.2

Supply Curve of the Fiasco Firm



11. To create the supply curve of this perfectly competitive firm, you used two important rules of profit maximization:
- (A) The firm's optimal Q level is the one where MR = MC.
 - (B) The firm should shut down if at its best Q level, TR < TVC or P < AVC.
12. In general, the supply curve of a perfectly competitive firm is that part of its marginal cost curve that lies above its average variable cost curve. Refer back to Figure 3-7.1 to see where you went at each of the four prices to find the best Q level for the firm.
13. What is the connection between a perfectly competitive firm having diminishing marginal productivity and its short-run supply curve being upward sloping?
- The short-run supply curve of a perfectly competitive firm is that portion of its MC curve above its AVC curve. The reason the MC curve is upward sloping is that the MPP of extra units of labor (the variable resource) is diminishing. The firm must receive a higher price to cover its higher MC if it is to produce additional units of output.*

Part C : Short-Run Supply Curve of a Perfectly Competitive Industry

The industry (or market) supply curve tells you how many units will be supplied by all firms at each possible price. To get the industry supply, you add the quantity supplied by each firm at each price. Economists call this *adding horizontally* because you add the quantity supplied (measured on the horizontal axis) at each price. Assume the Fiasco Firm is a typical firm in a perfectly competitive industry with 800 firms.

14. Complete Table 3-7.5. Refer to Table 3-7.4 for how many units a typical firm supplies at each price.



Table 3-7.5

Supply Schedule for the Industry (800 firms)

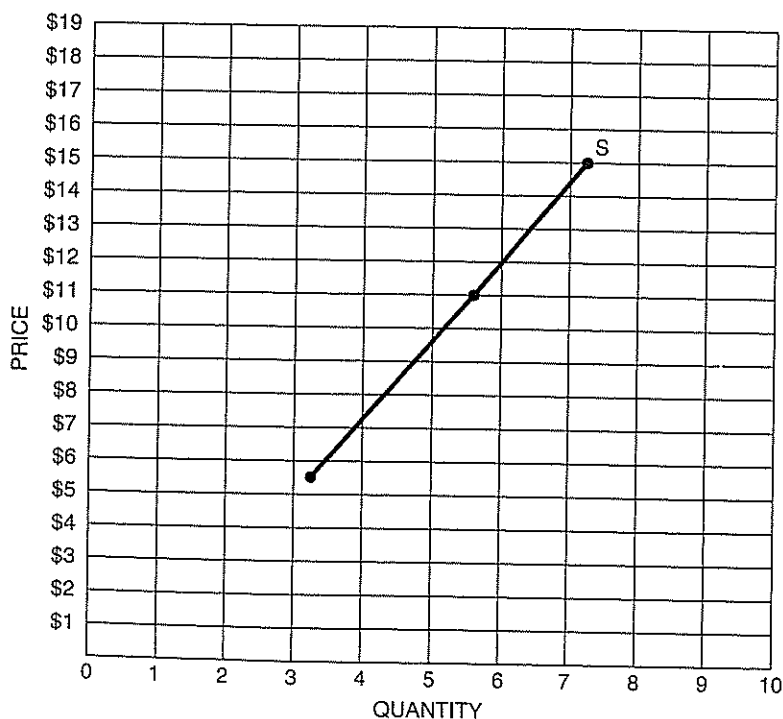
| P | Q supplied (units) |
|---------|--------------------|
| \$15.00 | 7,200 units |
| \$11.00 | 5,600 units |
| \$5.50 | 3,200 units |
| \$2.50 | 0 units |

15. Plot the data from Table 3-7.5 in Figure 3-7.3. Is the market supply curve upward sloping? Why?
The market supply curve is upward sloping because it is the summation of the upward-sloping supply curves of all the firms in the industry.



Figure 3-7.3

Market Supply Curve



Long-Run Equilibrium and Long-Run Supply in Perfect Competition

A firm is in a *short-run equilibrium (SRE)* position when it maximizes its total profit by producing the output level where marginal revenue equals marginal cost: $MR = MC$. When firms in short-run equilibrium in a perfectly competitive market are earning positive total profits, other firms will enter the market. If firms are making a loss in their short-run equilibrium position, over time some of the firms will exit the market. Eventually the perfectly competitive market reaches a *long-run equilibrium (LRE)* where all of the firms in the industry are earning zero total profits, based on the current market demand. Firms in other industries thus have no incentive to enter this market. And firms in this market have no incentive to leave it because they are earning their normal profit. An industry's *long-run supply (LRS)* curve is the set of LREs where each LRE is based on a different level of market demand. The shape of the LRS curve depends on how the production costs of firms change as the industry expands. The three cases to consider are *constant-cost*, *increasing-cost*, and *decreasing-cost* industries.

Part A: Movement from Short-Run Equilibrium to Long-Run Equilibrium

Table 3-8.1 presents some cost data for a typical firm in the perfectly competitive market for bricks. These cost data are shown in Figure 3-8.1.



Table 3-8.1

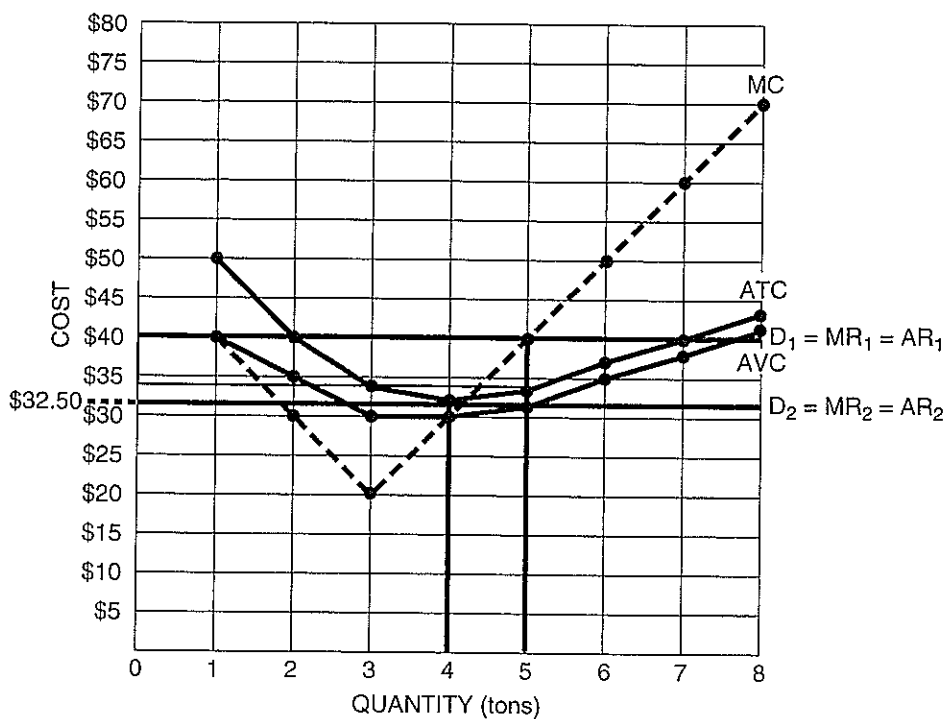
Cost Data for a Typical Perfectly Competitive Firm

| Output (Q) (tons) | Average total cost (ATC) | Average variable cost (AVC) | MC |
|-------------------|--------------------------|-----------------------------|----------|
| 0 | — | — | — |
| 1 | \$50.00 | \$40.00 | +\$40.00 |
| 2 | \$40.00 | \$35.00 | +\$30.00 |
| 3 | \$33.33 | \$30.00 | +\$20.00 |
| 4 | \$32.50 | \$30.00 | +\$30.00 |
| 5 | \$34.00 | \$32.00 | +\$40.00 |
| 6 | \$36.67 | \$35.00 | +\$50.00 |
| 7 | \$40.00 | \$38.57 | +\$60.00 |
| 8 | \$43.75 | \$42.50 | +\$70.00 |



Figure 3-8.1

Cost Functions of a Typical Firm



1. Complete Table 3-8.2, which shows how many units a firm will make available at different prices. Assume a firm cannot produce fractions of a unit.



Table 3-8.2

Supply Schedule of a Typical Firm

| Price (P) | Quantity supplied (Q_s) (tons) |
|-----------|------------------------------------|
| \$70 | 8 |
| \$60 | 7 |
| \$50 | 6 |
| \$40 | 5 |
| \$30 | 4 |
| \$20 | 0 |
| \$10 | 0 |

2. Assume there are 1,000 firms in the brick industry. Complete Table 3-8.3, which shows the market supply schedule. Information about the market demand schedule is included in Table 3-8.3.



Table 3-8.3

Market Supply and Demand Schedules

| P | Q_s (tons) | Quantity demanded (Q_d) (tons) |
|------|--------------|------------------------------------|
| \$70 | 8,000 | 2,000 |
| \$60 | 7,000 | 3,000 |
| \$50 | 6,000 | 4,000 |
| \$40 | 5,000 | 5,000 |
| \$30 | 4,000 | 6,000 |
| \$20 | 0 | 7,000 |
| \$10 | 0 | 8,000 |

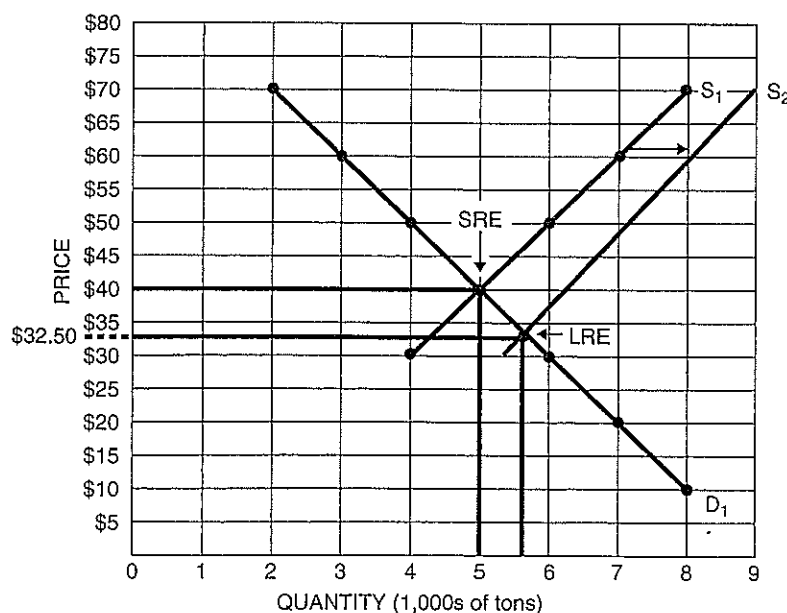
3. Figure 3-8.2 shows the market demand curve D_1 . Draw the market supply curve S_1 from Table 3-8.3. What is the equilibrium price of bricks? What is the equilibrium quantity? Label the SRE intersection of D_1 and S_1 as "SRE."

The equilibrium price of a ton of bricks is \$40 and the equilibrium quantity is 5,000 tons.



Figure 3-8.2

The Market for Bricks



4. In Figure 3-8.1, draw the marginal revenue (MR_1), average revenue (AR_1), and demand (D_1) curves of a firm at the equilibrium price. How many units will the firm produce to maximize its total profit? (Assume the firm cannot produce fractions of a unit.) Does this number agree with your work in Table 3-8.2?

The perfectly competitive firm will produce 5 tons of bricks. Yes, it agrees.

5. What is the value of the firm's average profit? What is the value of its total profit? In Figure 3-8.1, shade in the area representing its total profit.

$$A\Pi = AR - ATC = \$40.00 - \$34.00 = \$6.00.$$

$$T\Pi = Q \times AR = 5 \times \$6.00 = \$30.00.$$

6. Is the industry in a position of LRE? How do you know?

No, because firms are earning positive total profit.

7. Why will other firms want to enter this industry? Assume the cost curves of a typical firm in the industry do not change as new firms enter.

Other firms will enter the industry because firms are earning positive total economic profits.

8. As more firms enter the industry, the market supply curve shifts to the (right / left), which makes the market price (increase / decrease).

9. The industry is in a position of LRE when all firms break even based on the current level of market demand D_1 . What is the LRE price? Why?

More firms will enter the market until the price falls to the minimum value of a firm's ATC curve. As seen in Table 3-8.1, this is \$32.50.

10. In Figure 3-8.2, draw the new market S curve (label it S_2) that will result in this LRE price. Do not change the existing market demand curve D_1 . Label the LRE point as "LRE."

11. In Figure 3-8.1, draw the firm's MR_2 , AR_2 , and D_2 curves at the LRE price. How many units will the typical firm produce at this price? What is the total profit of a firm in this LRE position?

The typical firm will produce 4 units and earn a total economic profit of \$0.

12. If all firms in the market earn \$0 in economic profit, will other firms still want to enter the market? Will some firms want to exit the market? Why?

No other firms will want to enter the market because there are no economic profits. Firms now in the market will have no incentive to leave because they are earning their normal profits.

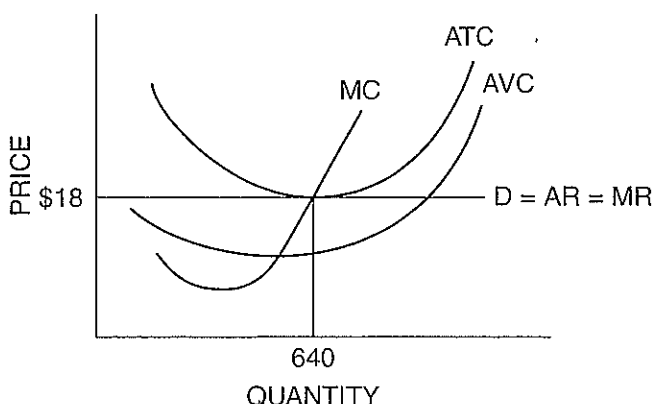
Part B: Long-Run Equilibrium for a Perfectly Competitive Firm

Let's leave the brick market and move to some other perfectly competitive market. Figure 3-8.3 shows a perfectly competitive firm in LRE, selling 640 units at a price of \$18.



Figure 3-8.3

A Perfectly Competitive Firm in Long-Run Equilibrium



13. What does it mean for a firm to be productively efficient? Is this firm productively efficient? How do you know?

A firm is productively efficient if its price is equal to the minimum value of its average total cost. This firm does exhibit productive efficiency. Consumers are getting the product at the lowest possible price.

14. What does it mean for a firm to be allocatively efficient? Is this firm allocatively efficient? How do you know?

A firm is allocatively efficient if its price is equal to marginal cost. This firm is allocatively efficient. It is producing the output level society wants it to produce. If there are no externalities (effects on other parties), then price measures the marginal social benefit (MSB) and MC measures the marginal social cost (MSC) of the last unit. Because $MSB = MSC$, the correct amount of society's scarce resources are being allocated to the production of this firm's product.

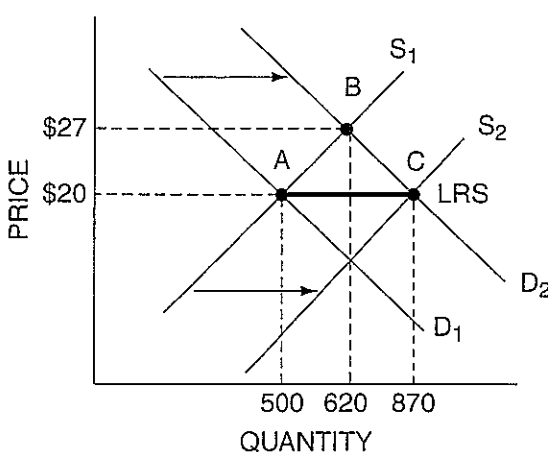
Part C: Long-Run Supply for a Perfectly Competitive Industry

The industry shown in Figure 3-8.4 is in LRE at point A with supply curve S_1 and demand curve D_1 . The market price is \$20, and the equilibrium quantity is 500 units. Now the demand for the industry's product increases to D_2 . The price increases to \$27 and quantity increases to 620 units. Because this boost in the market price results in positive total profits for firms in the industry, point B is considered a *short-run equilibrium (SRE)*. How the industry moves to its new LRE in response to this increase in demand depends on whether it is a constant-cost, increasing-cost, or decreasing-cost industry.



Figure 3-8.4

A Perfectly Competitive Industry



15. Assume the industry is a constant-cost industry. Explain how the industry moves to its new LRE. Show changes in supply and/or demand in Figure 3-8.4 and indicate the new LRE as point C. *Because of profits in the industry, other firms will enter. This makes the market supply curve shift to the right which reduces the market price. Since this is a constant-cost industry, the average total cost of production does not change as the industry expands. Thus, the supply curve will shift to the right to S_2 where it intersects D_2 at point C at the price of \$20. Firms will break even at this price as they did at point A. Point C is the long-run equilibrium based on demand curve D_2 .*
16. Is the new LRE price greater than, equal to, or less than \$20? Why? *The new LRE price is equal to \$20 because the average total cost of firms did not change as the industry expanded. The firms will break even at the original LRE price of \$20. The industry quantity has increased due to the inflow of new firms.*
17. The industry's LRS curve is the collection of LREs where each LRE is based on a different market demand curve. Draw a line connecting point A and point C, and label this line as "LRS." Is the LRS curve of a constant-cost industry upward sloping, horizontal, or downward sloping? What does this tell you about how price and quantity change as the industry expands in response to increases in demand? *The LRS curve of a constant-cost industry is horizontal. As the industry expands, the market price will not change as the market output increases.*

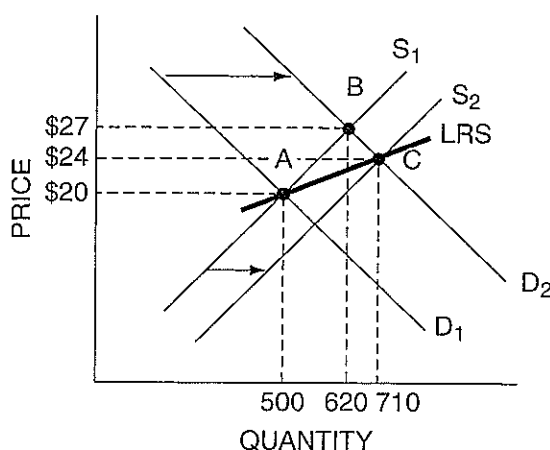
18. Now assume the industry is an increasing-cost industry. In Figure 3-8.5, the industry is in LRE at point A. When demand increases to D_2 , the industry moves to SRE at point B, where firms enjoy positive total profit. Explain how the industry moves to its new LRE. Show changes in supply and/or demand in Figure 3-8.5 and indicate the new LRE as point C.

Because of profits in the industry, other firms will enter. Two things happen to eliminate profits in the market. First, the market supply curve shifts to the right which reduces the market price. Second, since this is an increasing-cost industry, the average total cost of production increases as the industry expands. Thus, the supply curve will shift to the right to S_2 where it intersects with D_2 at point C at a price higher than \$20, say \$24. Firms will break even at this price as they did at point A. Point C is the long-run equilibrium based on demand curve D_2 .

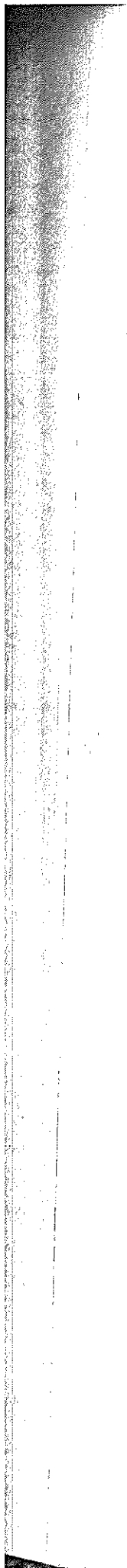


Figure 3-8.5

A Perfectly Competitive Industry



19. Is the new LRE price greater than, equal to, or less than \$20? Why?
- The new LRE is greater than \$20 because this is an increasing-cost industry. As the industry expanded, firms competing for needed resources drove up the prices of those resources, thus increasing the average total cost of production. This means the price will fall from \$27 but will not fall all the way back to \$20. Firms will break even at some price above \$20, say \$24.*
20. Draw a line connecting point A and point C, and label this line as "LRS" for long-run supply. Is the LRS curve of an increasing-cost industry upward sloping, horizontal, or downward sloping? What does this tell you about how price and quantity change as the industry expands in response to increases in demand?
- The LRS curve of an increasing-cost industry is upward sloping. As the industry expands, both the market price and output will increase.*
21. If the industry were a decreasing-cost industry, what would happen to the market price and quantity as the industry expanded? What would be the shape of the industry LRS curve?
- In a decreasing-cost industry, the market price will decrease and output increase as the industry expands. The LRS curve will be downward sloping.*



Graphing Perfect Competition

Figures 3-9.1 through 3-9.6 show side-by-side graphs of perfectly competitive industries and firms. Each pair of graphs illustrates the specific situation that is given.

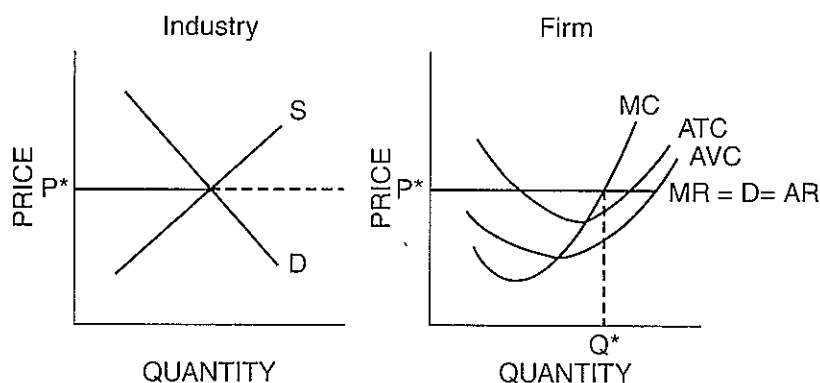
- For the industry's graph, draw the supply (S) and demand (D) curves. Indicate by P^* and Q^* the equilibrium price and quantity.
- For the firm's graph, draw the average total cost (ATC), average variable cost (AVC), average revenue (AR), and demand (D) curves. Indicate by P^* and Q^* the firm's optimal price and output.
- Explain the reasoning for your graphs in each situation.

- A firm earning positive total profit in the short run.



Figure 3-9.1

Short-Run Economic Profit



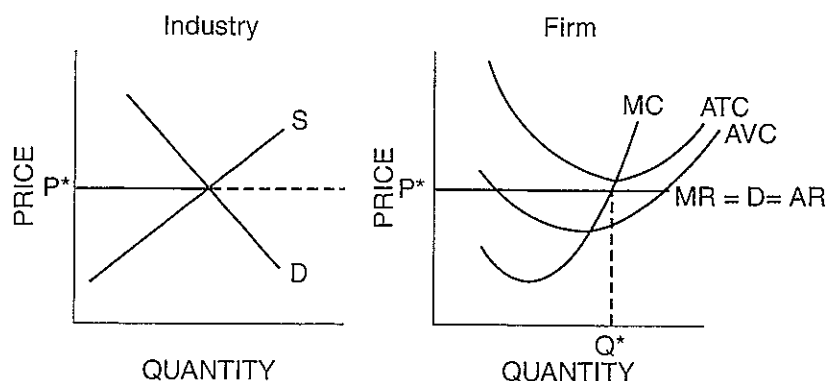
Explanation: *The firm produces Q^* where $MR = MC$. Because the market price P^* is greater than ATC, the firm earns positive total profit.*

2. A firm operating with an economic loss but not wanting to shut down in the short run.



Figure 3-9.2

Short-Run Economic Loss but Not Shutting Down



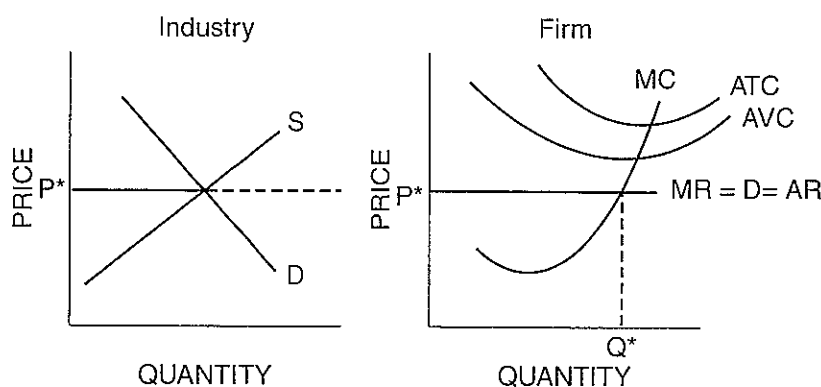
Explanation: The firm's optimal output is Q^* where $MR = MC$. Even though it will make a loss because the market price P^* is less than ATC , the firm will not shut down because P^* is greater than AVC . The firm is able to pay all its TVC and part of its TFC .

3. A firm in a classic shutdown position in the short run.



Figure 3-9.3

Classic Shutdown Position



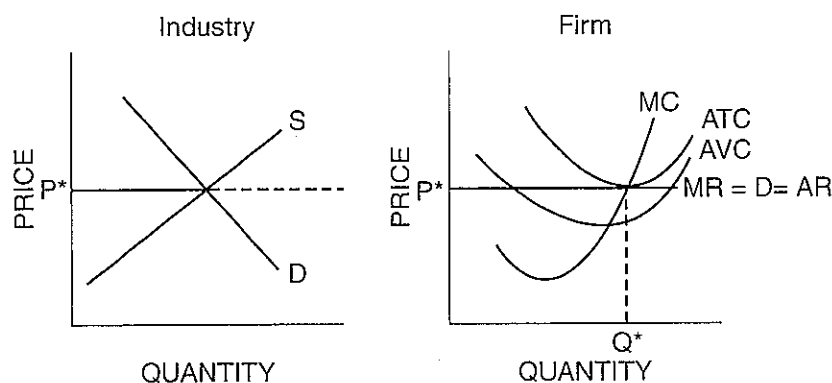
Explanation: At Q^* , where $MR = MC$, the market price P^* is less than AVC . The firm will shut down rather than produce Q^* . By shutting down, the firm's loss will be equal to its TFC . If it produces Q^* it will have a loss which is greater than its TFC .

4. LRE for a firm and the industry.



Figure 3-9.4

Long-Run Equilibrium



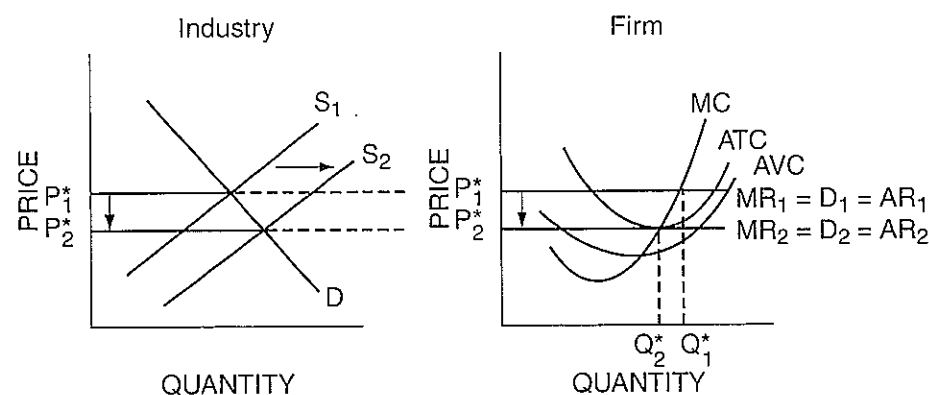
Explanation: The firm will break even with output Q^* , where $MR = MC$, because the market price P^* is equal to ATC at the minimum point on the ATC curve. The industry is in LRE: firms will neither enter nor leave the industry because the firms in the industry are earning a normal profit but no economic profit.

5. Illustrate how economic profits will disappear in the long run.



Figure 3-9.5

From Short-Run Profit to Long-Run Equilibrium



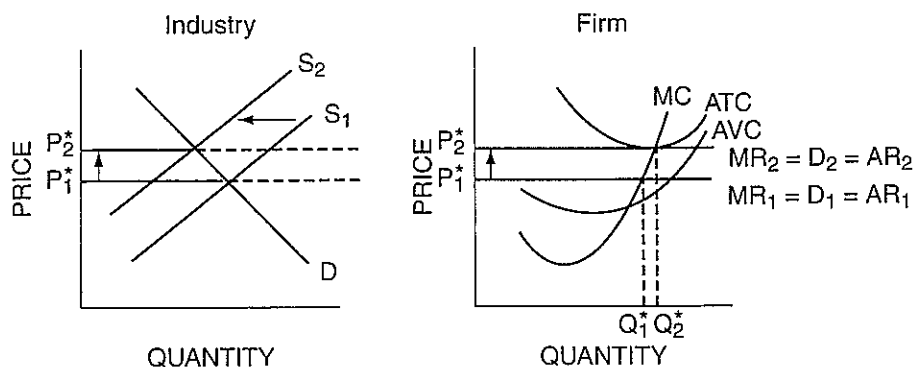
Explanation: With supply S_1 , the typical firm is earning a positive total profit at Q_1^* because the market price P_1^* is greater than ATC. As new firms enter the industry, attracted by the presence of profits, the market supply curve shifts to the right until it becomes S_2 which creates the market price P_2^* . At P_2^* , each firm breaks even because P_2^* is equal to ATC at the minimum point on the ATC curve. The industry is in long-run equilibrium. A firm produces Q_2^* and charges P_2^* .

6. Illustrate how economic losses will disappear in the long run.



Figure 3-9.6

From Short-Run Loss to Long-Run Equilibrium



Explanation: With supply S_1 , the typical firm is earning a negative total profit at Q_1^* because the market price P_1^* is less than ATC . As some firms leave the industry because of losses, the market supply curve shifts to the left until it becomes S_2 which creates the market price P_2^* . At P_2^* , each firm breaks even because P_2^* is equal to ATC at the minimum point on the ATC curve. The industry is in long-run equilibrium. A firm produces Q_2^* and charges P_2^* .